AD-A190 526 INSTRUMENTS FOR USE IN EXPERIMENTAL STUDIES OF COMPLEX TURBULENT SHEAR FL (U) STANFORD UNIV CA DEPT OF MECHANICAL ENGINEERING J P JOHNSTON 12 NOV 87 1/1

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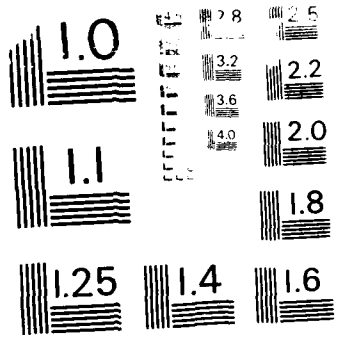

MICROCOPY RESOLUTION TEST CHART
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Development of instrumentation for use in low speed water flows of turbulent boundary and free shear (mixing) layers. Instruments measure three orthogonal components of velocity using LDV techniques. Results obtained concern effects of longitudinal curvature on turbulence structure.

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INSTRUMENTS FOR USE IN EXPERIMENTAL STUDIES OF COMPLEX TURBULENT SHEAR FLOW--THREE COMPONENT LDV'S

Grant No. AFOSR-86-0276

Effective date: 01 August 1986
Termination date: 31 July 1987

By

Stanford University
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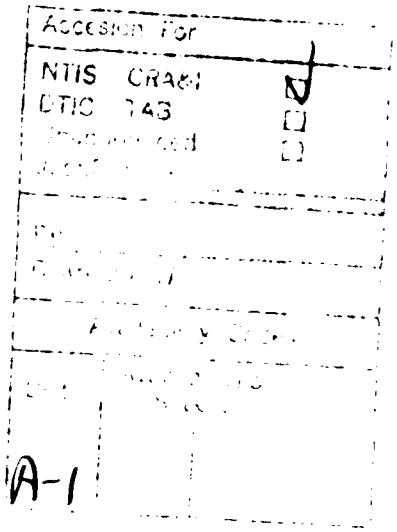

James P. Johnston

James P. Johnston

11 Nov. 1987

Date Submitted

to:

United States Air Force

Air Force Office of Scientific Research
Building 410, Bolling Air Force Base
D. C. 20332

Attention: Dr. James Wilson, and Dr. James McMichael

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PURPOSE

The goal of the grant was to enhance the capability of our laboratory to aquire detailed, quantitative, fluid velocity data in three orthorgonal directions simultaneously in our two, low-speed water flow channels. These facilities are being used to study the turbulence structure of boundary and free mixing layers perturbed by the effects of longitudinal curvature and high levels of free stream turbulence.

INSTRUMENTS

The grant allowed us to purchase a complete TSI Fiber Optic Probe system including a 35 mw Helium-Neon Laser. Also, we were able to obtain a second 2 w Argon laser, optical, mechanical and electronic components so that we have the ability to complete two, independent, three-component, traversible, LDV optical systems, one for each channel. The flow channels are close to each other so that the electrical and electronic components (counter processors, power sources, etc.) are shared. In addition, the fiber optic probe allows us to shift this probe easily between channels as the need requires.

The three beam, two-color, Argon system is set up as described in Barlow and Johnston (1985) to obtain streamwise, u-component, and normal, v-component. The w-component is obtained from the fiber optic probe using the He-Ne Laser. The probe body is mounted on a streamlined strut downstream of the u-v measuring volume with its beam intersection positioned in the u-v volume. There is no substantial flow interference as a result of the immersion of the small probe body in the flow. Its long axis is set nearly parallel to the main flow direction and its diameter is small relative to the distance upstream to the common measurement point defined by the intersection of all the beams.

UTILIZATION

The system on Channel No. 1, our concave wall boundary layer channel, is complete and detailed profiles of u, v, and w and all six Reynolds stresses have been acquired. A description of the measurement system and a preliminary report on this data will be presented at the APS, DFD annual meeting in November 1987, by P. L. Johnson and J. P. Johnston.

With some funds provided from other sources for additional required traversing equipment, the second system is currently being installed on Channel No. 2. This channel is now being used to investigate turbulence structure in curved free shear layers. In the future it will accommodate other other basic turbulent boundary and free shear layer studies.

In its first application, the fiber optic probe was used as a single component device. Profiles of u- and v-component data were obtained in three different two-stream mixing layers at a velocity ratio of 2 to 1. The three cases compare and contrast the effects of mild destabilizing curvature, mild stabilizing curvature in a curved channel to each other, and to a comparable straight mixing layer flow, Plesniak and Johnston (1987). These results will also be presented at the 1987 DFD meeting.

Publications Directly Related to this Grant

Barlow, R. S. and Johnston, J. P. (1985), "Structure of Turbulent Boundary Layers on a Concave Surface," Report MD-47, Thermosciences Division, M.E. Dept. Stanford Univ., Stanford, CA 94305. To be published as Parts 1 and 2 in the J. Fluid Mechanics in 1988.

Plesniak, M. W. and Johnston J. P. (1987), "The Effects of Stabilizing and Destabilizing Curvature on a Turbulent Mixing Layer," Proceedings of the 2nd International Symposium on Transport Phenomena in TURBULENT FLOWS, Tokyo, October 25-29, 1987, Hemisphere Publishing Corp (to appear in 1988)

Presentations Directly Related to this Grant

Johnson, P. L. and Johnston J. P. (1987), "The Effects of Freestream Turbulence on Concave Turbulent Boundary Layers," DFD of APS Annual Meeting, Eugene OR, Nov. 22-24, 1987

Plesniak, M. W. and Johnston J. P. (1987), "The Effects of Stabilizing and Destabilizing Curvature on a Turbulent Mixing Layer," DFD of APS Annual Meeting, Eugene OR, Nov. 22-24, 1987

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